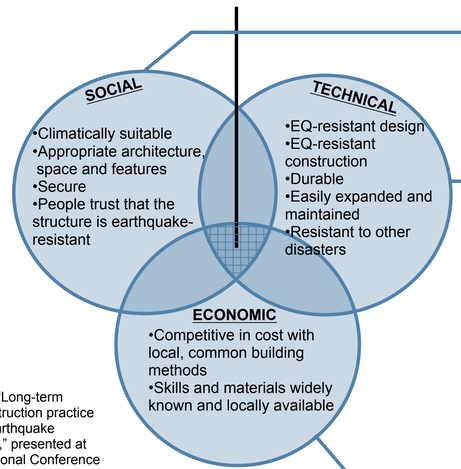
Post-earthquake Seismic Retrofit Programs for Improved Reconstruction

by M. Lisbeth Blaisdell, S.E.[1]
[1]Director of Engineering, Build Change, lizzie@buildchange.org, 900 Bay Drive #1022, Miami Beach, FL 33141

Criteria for Successful Post-earthquake Housing Reconstruction Programs[a]



[a] E. Hausler, "Long-term change in construction practice through post-earthquake reconstructions," presented at the 1st International Conference on Urban Disaster Reduction, Kobe, Japan, 2005.

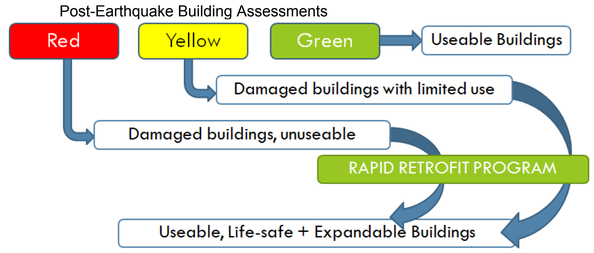
Observed Advantages of Retrofitting vs. New or Temporary Homes[b]

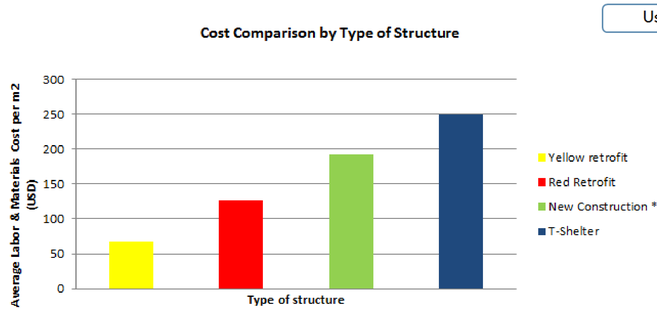
•**Increased Homeowner Satisfaction** - Retrofitted houses are improved, safer versions of the houses that the same families lived in before the earthquake – the ones the homeowners chose to build or buy originally - and can function in the same or an improved way. At the end of a retrofit program in a neighborhood it is a safer, spruced-up version of its former self, not a mass-produced neighborhood where all houses look almost the same, so its character is retained. Additionally, families are displaced for much less time while their houses are being retrofitted than with other solutions.
•**Observable Improvements to the Structure** - The retrofit measures may make minor or significant noticeable changes to the building. These are observable by the homeowners so they can better understand and appreciate the strengthened aspects and improved safety of the house.

•**Improving Existing Practices** - Local engineers and builders are trained to design and construct retrofit solutions. This approach promotes an understanding of the key weak points in the existing construction practice that led to the catastrophic loss. These skills will be used in the future to design and build safer structures. Retrofitting can be done with local materials and labor, putting resources back into the local economy
•**Strengthen for Future Expansion** - Houses can be retrofitted considering demands from future additions, which would put more safe, habitable space back on the market.

After retrofit and expansion (left)
Before (below)

Purpose of a Post-Earthquake Seismic Retrofit Program





•**Lower Cost** - Retrofitting is significantly cheaper in terms of materials and labor than the other options, providing more safe floor space per dollar spent. Parts of houses that are intact and structurally sound can be part of the retrofitted structure, rather than being torn down to make way for a new house.
•**Skip Temporary Shelter Phase** - Because a retrofit program can be started early in the relief process, even while rubble is being cleared, money that would have been spent on temporary solutions can be allocated earlier to permanent solutions.

Components of a Post-Earthquake Seismic Retrofit Program[b]

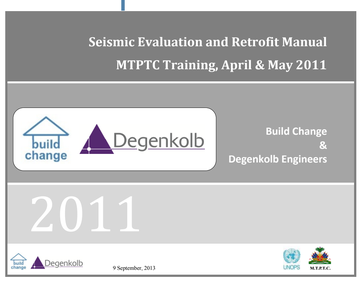
Pre-Evaluation Activities → **Seismic Evaluation** → **Analysis & Design** → **Retrofit Construction Implementation**

- Understand post-disaster context
- Understand technical context
- Clarify objectives & define guidelines
- Prepare for implementation
- Homeowner preference survey
- Site survey & documentation
- Existing building survey & documentation
- Technical evaluation
- Calculations
- Retrofit design
- Detailing & cost estimation
- Homeowner validation
- Training & awareness for homeowners
- Retrofit technique construction training
- Construction quality supervision
- Quality-conditional advancement

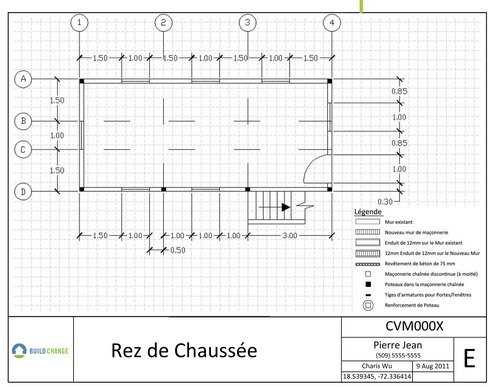
Examples from Post-Earthquake Seismic Retrofit Programs in Haiti

Unreinforced Concrete Block Masonry (essentially elastic)

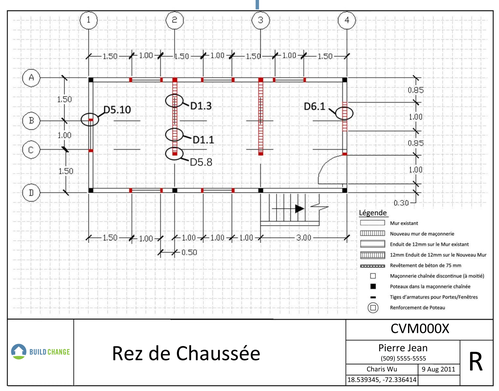
Confined Concrete Block Masonry (low ductility)

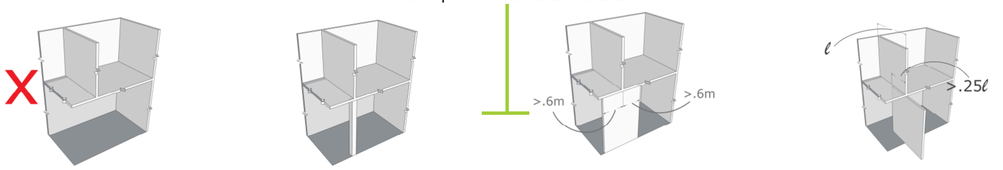


Build Change developed, in collaboration with Degenkolb Engineers, seismic evaluation and retrofit guidelines for small masonry buildings in Haiti, based on the provisions and methodology of the U.S. standards, ASCE 31 and ASCE 41. The Haitian Ministry of Public Works, Transport and Communications (MTPTC) adopted these guidelines. The performance objective is life-safety performance for the design earthquake hazard level (2/3 Maximum Considered Earthquake)



Example: ***5.3: Vertical Discontinuities***





NC - Second floor walls not aligned

C – Provided free-standing column is compliant, see Item 6.1

C - There are perpendicular walls that extend at least 60cm on each side of the wall above

C - There are parallel walls with at least ¼ length upper wall overlapping with the lower wall

Reviewing design with the homeowner

Training and awareness classes with homeowners.

Building inspection engineer and design engineer review work of builders on site.

BUILD CHANGE

[b] Build Change for Parsons Engineering for USAID, *Seismic Retrofit of Housing in Post-Disaster Situations - Basic Engineering Principles for Development Professionals: A Primer*, January 2014.